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Potassium-Argon Dates from the Cobaw Granite, Central Victoria

By A. J. Stewart*

Abstract: Four biotite samples from the three largest intrusions of the compound Cobaw Granite have been dated by the potassium-argon method. The four dates (347, 358, 359, and 361 m.y., all ± 7 m.y.) are all Late Devonian on the Kulp time-scale, or Early Carboniferous if the Devonian-Carboniferous boundary of McDougall *et al.* (1966) is used. The dates agree with the Devonian-Carboniferous age assigned to all the central Victorian granites on stratigraphic grounds.

INTRODUCTION

The Cobaw Granite is situated in central Victoria, about 50 miles N. of Melbourne (Fig. 1). It is one of several large, post-orogenic, subvolcanic granite plutons that were emplaced into the folded and faulted Lower Palaeozoic sediments

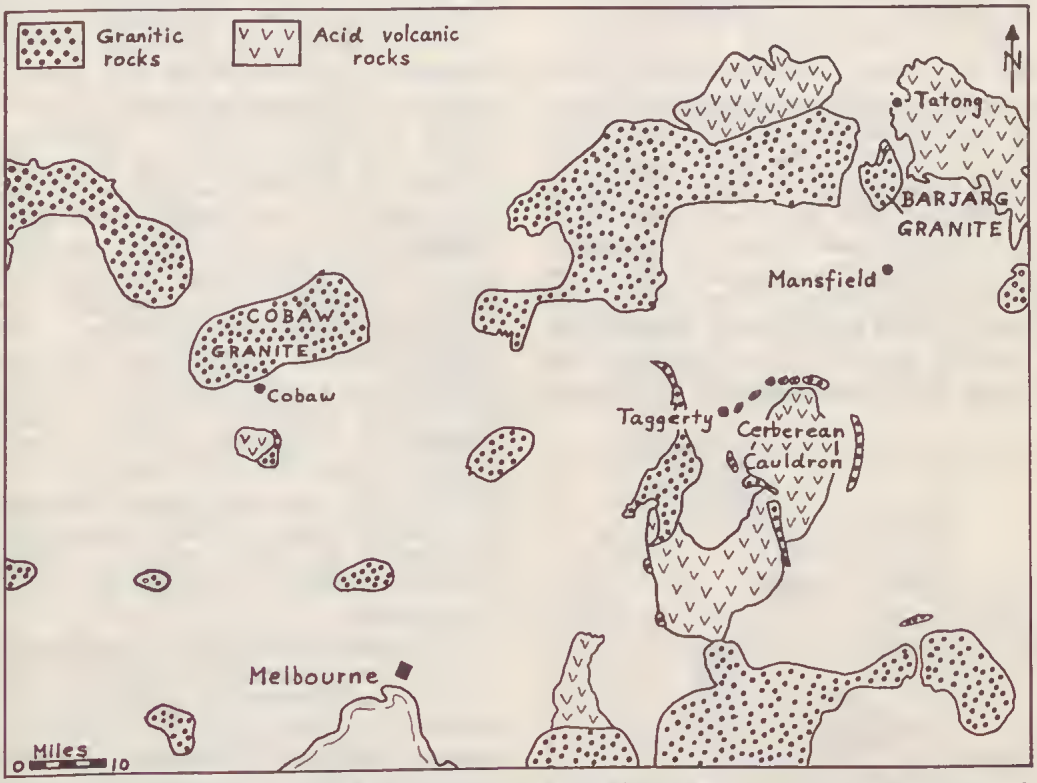

Fig. 1—Locality map of central Victoria, showing major areas of acid igneous rocks and localities referred to in text. Geological boundaries taken with slight modification from Geological Map of Victoria, 1963, 1:1,000,000, published by the Department of Mines, Melbourne, Victoria.

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of the Lachlan Geosyncline after the Tabberabberan Orogeny, which occurred in the later part of Devonian times. Some of these granites intrude acid volcanic rocks that formed an early extrusive phase of the magmatic activity (Hills 1959). On stratigraphic and palaeontologic evidence, the time of emplacement of the granite plutons is bracketed between Late Devonian and Early Carboniferous; clastic sediments interbedded with the acid volcanics of the Cerberean cauldron at Taggerty contain Late Devonian fish fossils (Hills 1931), and sediments with Early Carboniferous fish fossils (Woodward 1906) unconformably overlie granite that intrudes similar cauldron volcanics near Mansfield (Brown 1961). However, up to the present time, only one age determination on the central Victorian granites themselves has been published, viz., a Rb/Sr date of 369 ± 11 m.y. (Late Devonian) on the Barjarg Granite (McDougall *et al.* 1966).

GEOLOGICAL SETTING OF THE DATED SAMPLES

The Cobaw Granite has been described by the author in an earlier paper (Stewart 1966). The massif, shown in outline in Fig. 2, comprises a large mass of medium-grained granodiorite G3, and a wide ring of coarse-grained granite G2 that surrounds G3. A smaller mass of porphyritic granodiorite G4 interrupts the ring of granite for some 6 miles along its southern side, and has a transitional contact with G3. The earliest intrusion, G1, is an irregular dyke of hypersthene porphyrite situated outside the granite ring at its north-eastern corner. Sample 1 of the present study comes from the south-western corner of the granite ring G2, samples 2 and 3 are from two different parts of the granodiorite G3, and sample 4 is from the porphyritic granodiorite G4; the sample locations are shown in Fig. 2. All the samples were taken from fresh rock blasted loose during road construction by the local authorities. The three rock-types are described petrographically in Stewart (op. cit.).

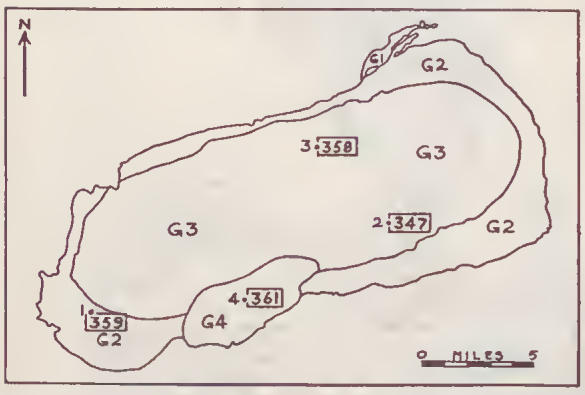

FIG. 2— Generalized geological map of Cobaw Granite, showing boundaries of major intrusions (G1 to G4), locations of dated samples 1 to 4, and the dates obtained (in m.y.; in rectangles).

ANALYTICAL METHODS

Potassium in the samples was determined by atomic absorption spectrophotometry, and argon was extracted, purified, and its composition determined by conventional isotope dilution techniques, as set out in Armstrong (1970). The precision of the dates is 2% (σ). All dates were calculated using the constants $K\lambda\beta = 4{\cdot}72 \times 10^{-10}$ yr^{-1}, $K\lambda_e = 5{\cdot}85 \times 10^{-11}$ yr^{-1}, $K^{40}/K = 0{\cdot}0119$ atom per cent. The analyses were made on mica separates obtained from the crushed and sieved whole rock, using a vibrating table and bromoform.

RESULTS

Sample descriptions, analytical data, and K-Ar dates are set out in Table 1, and the dates are plotted in Fig. 2. Kulp (1961) placed the Devonian-Carboniferous boundary within the volcanic succession of the Cerberean cauldron, and assigned to it a date of 345 m.y., basing this in part on a biotite date of 344 m.y. from the Cerberean volcanics themselves (Evernden *et al.* 1961); this biotite date was later revised to 345 m.y. by Evernden and Richards (1962). On this basis, the four samples from the Cobaw Granite are all Late Devonian in age. McDougall *et al.* (1966) redetermined the age of the Cerberean volcanics, and concluded that the Devonian-Carboniferous boundary should be placed at 362 ± 6 m.y.; using this figure, the Cobaw Granite samples are all Early Carboniferous in age. Samples 1, 3, and 4 straddle the Devonian-Carboniferous boundary of McDougall *et al.* when the ±7 m.y. errors are taken into account. The four dates are in agreement with the Late Devonian to Early Carboniferous age assigned to the central Victorian granites from the stratigraphic and palaeontologic evidence discussed above.

With regard to the order of emplacement of the three intrusions sampled in this study, the radiometric dates add little of significance. The field evidence, summarized in Stewart (op. cit.), indicates clearly that the sequence of intrusion was G2, G3, and G4, in that order. The two dates on G3 (347 and 358 m.y.) are slightly younger than the 359 m.y. for G2, as they should be, but, on the other hand, the 361 m.y. determined on the youngest intrusion G4 is the oldest of the four dates found. However, the closeness of the four

dates and the resulting overlap in their errors virtually prohibits the drawing of any conclusions from the age data regarding the order of emplacement of the three intrusions. Rather, it appears that the several intrusions forming the Cobaw Granite cooled essentially as a single mass.

ACKNOWLEDGMENTS

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TABLE 1

SAMPLE DESCRIPTIONS, ANALYTICAL DATA, AND K-Ar DATES FOR THE COBAW GRANITE

Sample No.	Lithology	Material* Dated	%K	Radiogenic Ar STP (cc/gm) $\times 10^6$ (per cent air correction in parentheses)	Date (m.y.)
1	Granite (G2)	Biotite (1% chlorite)	7·29, 7·39	115·96 (9)	359
2	Granodiorite (G3)	Biotite (2% chlorite, tr. hornblende)	6·51, 6·57	99·55 (9)	347
3	Granodiorite (G3)	Biotite (2% chlorite, tr. hornblende)	6·46, 6·51	102·14 (4)	358
4	Granodiorite (G4)	Biotite (3% chlorite, tr. hornblende)	5·51, 5·62	87·83 (5) 88·96 (5)	359 363 av. = 361

* *Chlorite percentage reported is estimated from the heights of the 14 Å and 10 Å peaks on X-ray diffraction curves; it is not an accurate measure of the actual chlorite content. Presence of hornblende indicated by X-ray diffraction curve.*